IO Center
Center for Integrated Operations in the petroleum industry
Introduction to Integrated Operations

IO is the integration of people, work processes and technology to make smarter decisions and better execution. It is enabled by using shared real time information, collaborative techniques and multiple expertise across disciplines, organizations and geographical locations.

Through the last decades, the traditional strategy for managing the complexity of oil and gas fields has been to organize people, work processes and technology in “silos” (reservoir, drilling, production, operation and maintenance, logistics). Obviously, this strategy has not taken full advantage of the synergies and interdependencies between the silos. By connecting people, processes and technology across disciplines, organizations and geographical locations through Integrated Operations, it will be possible to make smarter decisions leading to increased value generation and enhanced safety.

In the near future decisions will be made by teams and networks across organizational, functional and geographical domains. Experts from anywhere in the global organizations of the oil companies and their suppliers will work together to solve specific problems of a given asset. The teams will have at their hands real time analyzed information collected from a variety of information systems, which previously did not communicate easily.

This future perspective is raising several issues regarding new business processes, organizational culture, collaboration environment, advanced mathematical modeling and data integration, just to mention a few. Although the oil companies and service suppliers already have gained experience with solutions for Integrated Operations, there are still many challenges left, where further research and development is needed. This is the motivation for the IO Center.
Key elements in Integrated Operations

Horizontal integration from reservoir to process facility - Vertical integration from data to decision

Integrated planning and execution

Smarter decisions

Decision processes across disciplines and organizational boundaries

Visualization Communication

Data acquisition Communication

Data processing, modeling, prediction Decision support

Integrated decision and planning processes

Integrated information, visualization

Integrated modelling and analysis tools

Data integration

RESERVOIR

WELLS

PROCESS FACILITIES

www.iocenter.no

IO Center Annual Report 2010
Overview of programs and projects in Phase I (2007-2011)

Phase II of the IO Center, 2012-2014

Planning of a second phase of the IO Center (2012-2014) started in 2010. The Center was evaluated by an international expert panel on commission from the Research Council of Norway. The evaluation concluded that the IO Center had succeeded in achieving its targets, and a continuation for 3 years was recommended. The Research Council has awarded 30 million NOK for the extended 3 year period.

The industry partners will make their decision during 2011 on continued membership in Phase II. Some new partners will also be invited. The IO Center partners have prioritized new areas of research for Phase II during 2010. Some new targets have been proposed:

- More weight on integration across programs
- Harvesting and implementation of results
- More active participation from both oil companies and suppliers in research activities
- Risk and integrity management
- Capability/performance of IO compliant organizations

International evaluation of the IO Center

The IO Center was evaluated by an international expert panel in October 2010. The evaluation report concluded:

"The IO Center has rapidly grown into an efficient research organization with strong support from industry and producing results that create considerable potential for innovation in the petroleum industry and its suppliers. We commend this achievement and note that it would be a considerable loss if the high and coherent competence represented by IO Centre were not preserved".
IO Center partners

Research partners

Industrial partners

Collaborating international academic partners

Two new industrial partners joined the IO Center in 2010; Petrobras and SKF, both bringing important knowledge and experience to the IO Center.

Key figures for the IO Center in 2010

<table>
<thead>
<tr>
<th>Human resources</th>
<th>Number</th>
<th>Man years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Scientists</td>
<td>55</td>
<td>16</td>
</tr>
<tr>
<td>Guest Research Scientists</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>PhD students, funded by IO Center</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>PhD students, associated</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Postdoctorate students</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total man years</strong></td>
<td></td>
<td><strong>38</strong></td>
</tr>
<tr>
<td>Master students (graduated 2010)</td>
<td>30</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal papers</td>
<td>12</td>
</tr>
<tr>
<td>Conference papers</td>
<td>25</td>
</tr>
<tr>
<td>Technical reports</td>
<td>9</td>
</tr>
<tr>
<td>Workshops, internal seminars</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Funding and costs</th>
<th>Million NOK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Council of Norway</td>
<td>11</td>
</tr>
<tr>
<td>Industrial partners</td>
<td>27</td>
</tr>
<tr>
<td>Research partners</td>
<td>6</td>
</tr>
<tr>
<td><strong>Sum funding</strong></td>
<td><strong>44</strong></td>
</tr>
<tr>
<td><strong>Sum operating costs</strong></td>
<td><strong>44</strong></td>
</tr>
</tbody>
</table>
Program 1 Drilling and Well Construction

Rate of Penetration analysis
Analysis of Rate of Penetration (ROP) from the Visund Wired Drillpipe data shows that the role of formations parameters is complex. Particularly, the effect of porosity is different for shale and sandstone formations. For sandstone, an increase in porosity leads to a marked increase in ROP while for shale/sandstone, porosity seems to have little effect on ROP. This demonstrates the capability of Wired Drill Pipe technology to provide important new information while drilling, which can be used to optimize the drilling process, and give a better subsurface understanding. Program 1 in the IO Center will pursue the research on new opportunities for smarter decisions enabled by this technology.

Four models think better than one
Bringing together a group of experts from different backgrounds may often produce better results than each expert working alone. This turns out to be true for computer models as well. In a collaboration between two projects on drilling diagnostics and condition monitoring/data analysis, four computer models were developed to make real-time predictions of the bottom hole pressure during a managed pressure drilling operation. As seen here, each model made its own set of mistakes. But they did not make the same mistake at the same time. This allowed us to produce a new prediction of the pressure that was more accurate than what each model produced on its own. The main advantages of this approach are:

- A limitation in one model is corrected by the others, improving accuracy and reliability of the real-time prediction
- The different models rely on different parts of the data stream from the rig. When poor data ruin the prediction of one model, other models can fill in. The system is therefore more robust to poor data quality than any single model.
- Existing systems in a company can be combined with other systems from different vendors at a minimal cost. Only the output from each model is needed.

Left: Four independent models (red curves) try to predict the bottom hole pressure (blue) in a well during a managed pressure drilling operation.
Right: Taking a consensus among the four models results in a new prediction that is better than any of the original ones.
Providing support for achieving “common team assessment” in the drilling team

In collaboration with Statoil and ConocoPhillips this project aims to create a foundation for improved support for teams in pursuit of improved collective learning and performance. Statoil has implemented the “A-standard training concept” to ensure a more uniform process for risk and performance management in the organization. Focus is placed on the robustness of teams and the team’s ability to make collective assessments with regard to proposed methods of work, problem solving and learning. The project has developed a structured method comprising the how-/what-/why-learning charts to study drilling teams in their daily work activities. The charts consist of structural and enabling parameters supporting balanced learning process and optimal performance environment. So far the project has focused on the following success factors for the team’s performance and learning:

- The team’s ability to use relevant information and know-how and reach basis for decision making.
- Team diversity, both in terms of formal competence, past experience, communication aspects and individual use of information resources.
- Leadership as a factor to enable successful collaboration within IO, and the leader’s role in influencing team performance.
- Balance between use of procedures and using the team’s own competence and autonomous team evaluation. How to make procedures at the right level compared to the competence of the team?
- The use of boundary objects (a representation of a topic or system reflecting the current state of the issue addressed) to support shared understanding of a problem related to challenges encountered during planning or execution.

Wired to Drill: Investigating the Potential of Wired Drill Pipe

Wired drillpipe is now a proven technology that lets us retrieve massive amounts of data from downhole, both from the near-bit area and along the entire drillstring. This technology demands that routines for work processes and decision making must be reconsidered if the potential of this new and exciting technology is to be realized.

The project analyses data recorded with wired drillpipe and studies how existing drilling diagnostic and decision support software can be extended. Activities include a Ph. D. project on optimization of Rate of Penetration. A Data Quality workshop with industry participation was held in 2010 and will be followed up in 2011 with an analysis of data quality based on logged data from IO Center members.

One activity focuses on making use of borehole seismic data together with realtime measurements of formation parameters to form an improved “image” of the underground. Applications range from optimal placement of the wellbore, improved reservoir drainage, and production planning.

To investigate the feasibility of receiving and processing seismic data during drilling, simulations of seismic signals acquired during drilling have been performed. The illustration shows imaging of a fault plane 500 m ahead of the drill bit. The acoustic source is located at the drill bit while receivers are distributed along the wellbore. The simulations show promising results in providing an update of the geological model ahead of and around the drill-bit.
Program 2 Reservoir management and Production Optimization

Subsurface IO

A large portion of the IO value potential lies in enhanced reservoir management through model supported tools for decision making. Such tools provide platforms for efficient knowledge integration across the subsurface disciplines. We try to develop fast, reliable and transparent methods and test them on realistic cases. Further, our aim is to challenge the dominant silo approach and bring IO to a next level through integration of models and optimization applications.

Norne benchmark case – unique opportunity for testing new methods for reservoir management

The Norne field case offers industry and research a unique environment for comparing technologies for closed loop reservoir management.

The Norne field case provides users with a benchmark based on real sub surface data. This is an extension to current benchmark cases which are all based on synthetic data. The Norne field on the Norwegian Continental Shelf is operated by Statoil, and includes the license partners ENI and Petoro.

4D seismic analysis

An interesting feature of the benchmark is high quality 4D seismic data, where the depletion of the reservoir is monitored through seismic measurements from permanently installed sea bottom sensors. This is a new technique for increasing the recovery from oil and gas fields, used on a few fields around the world. The IO Center develops new analysis tools to extract information on the depletion history to understand better the reservoir behavior and optimize the positioning and operation of new production and injection wells.

First benchmark

The first benchmark case contains production and seismic data for the Norne E-segment until 2004. The challenge is to history-match the model using the provided data, and to find an optimal production strategy for the time frame 2005-2008. Research groups at Stanford University, TU Delft, Texas A&M University, UT Austin, Herriot Watt University, University of Bergen, NTNU, TNO, IRIS and SINTEF are currently using the data. Results will be presented and discussed at an SPE Applied Technical Workshop organized by the IO-center June 2011.

Interactive Well Placement Screening

A visualization tool for interactive simulation output intended for optimal well placement screening is being developed.

The decision on location and trajectory for a new well has a vital impact on future reservoir recovery and production. In the decision making process predicted reservoir performances for potential well placements are evaluated using time-consuming reservoir simulations, and in practice this limits the number of scenarios considered due to time constraints.

In the tool we are developing, the engineer will have the ability to interactively perform multiple fast approximate simulations which widens the search space considerably. This means that promising potential well placements, otherwise missed, can be identified. After such a screening, only the most promising scenarios can be selected for further evaluation using the standard simulator. As a result, compared to the traditional approach, a better well placement in terms of recovery and production can be identified, and secondly the number of time consuming simulations runs can be reduced.

In this project we combine state-of-the-art model reduction techniques for fast simulations with state-of-the-art visualization software to enable interactive simulation output. An early prototype of the tool has been developed together with Kongsberg O&G using their visualization software SIMReservoir. The next step will be developments of the tool for testing on a real field case.
Production optimization

A new tool for production optimization on a daily basis

A new concept based on decentralized optimization for production optimization has been developed. Testing on real data indicates a significant potential for this methodology.

The daily workflow for a production engineer typically starts with a review of production and well performance. Production engineers need to analyze the current situation and recommend a future production strategy. Hence, a decision support tool is often desired for allocating production from individual wells. We have developed a novel decomposition and modeling method which is highly efficient, partly because it may be implemented in parallel computer architecture.

One of our PhD students has spent 6 months at Troll Petek, and 5 months at FMC Technologies in addition to several visits to IBM T.J. Watson research labs. Hence, we have had the opportunity to assess the proposed methodology on real data with encouraging results.

Integrating models along the value chain

The integrated optimization model will challenge industry views on the business potential of value chain integration. Integrated modeling of multi-field assets, from subsurface to market, is challenging due to the complexity of the problem. We have developed an integrated optimization model and tested this on a synthetic gas/condensate field, as a means to assess the potential business value of integrating applications along the value chain from reservoir to export. Tests have shown 5-20% improvement compared to base case.

Simulator optimization

Maintaining good or optimal operations of large and complex petroleum assets is not a trivial task. Operators and engineers may therefore rely on simulators and “what if analysis” to predict system behavior and to evaluate alternative strategies. However, searching for the optimal production strategy by running simulators in a “trial and error” mode is not efficient.

Therefore, a natural extension of simulator capability is to automatically generate optimal scenarios which are presented as recommendations to the operators and engineers. We expect this capability to result in more efficient collaboration, workflows and smarter decisions.

State-of-the-art optimization techniques are the main constraining factor in achieving this capability, and we are therefore developing a new optimization framework to overcome this. The project has received two Open Collaboration Research grants, each of 100 000USD, from IBM research, and considerable interest from industry. Currently there are four IO center partners involved; FMC Technologies, Statoil, Kongsberg Oil & Gas and IBM.
Program 3 Operation and Maintenance

Program 3 is made up of three projects centered on a common objective: to provide efficient decision support for operation and maintenance of offshore assets. Project 3.1 focuses on data availability, data quality and how measured data can be transformed into knowledge. The project has activities looking into the feasibility of remaining useful life estimation for components. Project 3.2 focuses on the capture of data and the level of quality delivered by different technologies and methods. Project 3.3 focuses on integration of planning teams across disciplines, and planning processes in which the availability of high quality data is crucial for efficient planning.

Remaining Useful Life (RUL) - Developing the ability to look into the future

Condition based maintenance (CBM) aims at regulating maintenance scheduling based on data analyses and system condition monitoring. Clear advantages of optimizing maintenance scheduling include relevant cost savings, improved safety and asset availability. A critical aspect is the integration of CBM strategies with condition monitoring technologies for handling a wide range of information sources and eventually making optimal decisions on when and what to repair, balancing maintenance costs against risk of breakdown. A critical question for condition based maintenance then becomes: What is the remaining useful life (RUL) of a component or a system?

During 2010, in addition to further developments of the Mímir platform for real time data analysis and interpretation, a practical case study concerning maintenance of choke valves in offshore oil platforms has been investigated in cooperation with Statoil, with the aim of developing reliable RUL models. Choke valves undergo slow, progressive erosion which, if not properly detected and managed, can seriously affect their correct operation, and eventually result in production and revenue losses.

Sand eroded choke valve.

In this respect, research has focused on the following issues:

- The development of methods for calculating reliable erosion indicators.
- The actual estimation of the RUL of the valves based on the erosion indicators. In this respect, mathematical modeling methods are used for estimation; so called Gamma and Wiener processes as well as Kalman-filtered ensembles of models have been developed and compared.
- The investigation of methods to reduce the uncertainty of the RUL estimation by combining statistical approaches to the actual knowledge of the erosion state of the choke valve.

NEXT STEPS:

- Definition of a general maintenance strategy for choke valves based on automatic data acquisition, treatment and processing
- Implementation of the prognostic system for RUL estimation as a Mímir on-line application and practical application in a pilot installation

Trended RUL for a choke valve – Reducing uncertainty as more data becomes available.
Condition monitoring – Developing the ability to see what can not be seen

The use of condition monitoring (CM) may increase revenues and safety levels for offshore static process equipment. Traditionally, static equipment has received less attention than rotating equipment regarding condition monitoring methods. This project is focusing on how condition monitoring can be improved for separators, heat exchangers and safety critical valves.

Separators
Work performed on separators in 2010 has demonstrated the ability of gamma transmission measurements, utilizing instrumentation tubes, for presence detection of inlet cyclone, and liquid/gas distribution along this. Further, monitoring of acoustic signals has been tested with 3-phase flow, demonstrating detection of different cyclone conditions (presence detection, and detection of sand and foreign objects). The method needs to be verified on full scale separators, and possibilities for field testing have been discussed in cooperation with relevant operators.

Particle detection in separators.

Separator test rig at Marintek laboratories.

Heat Exchangers
Heat exchangers are challenging to maintain, and a major part of their failure notifications are based on observations by experienced personnel. Work performed on heat exchangers includes investigation of main potentials related to use of CM. In cooperation with Statoil and Aker Solutions, three important areas have been identified; 1) improved utilization of process data, 2) analysis of root causes which can eliminate several failure conditions, and 3) development of improved condition monitoring techniques. The work includes identification of important root causes and initiation of cost-benefit methodology for selection of condition monitoring methods for optimum coverage.

Safety critical valves
Work performed on safety critical valves in 2010 has been performed in cooperation with the external project TAIL/IO, and includes use of acoustic emission and fluid pressure fluctuation analysis for internal leakage detection. The sensors in combination with frequency domain analysis techniques, are effective in detecting leaks, but methods for accurate quantification of leaks needs further research.

Plans are useless, but planning is everything
(General Dwight D. Eisenhower)

Integrated planning is about how planning is carried out in practice and how planning processes can be developed and improved, based on the principles that form the basis for Integrated Operations. Thus, important elements are improved understanding of information sharing and communication across disciplines and organizations for better decision making and conflict resolution in planning.

Mapping tool for integrated planning
In 2010 the IPL project has focused on development of a tool supporting the main goal of the project called the “IPL mapping tool”. The tool measures the maturity of IPL in an organization by combining observations, interviews, surveys and workshops. The tool can be used by the industry partners as part of a development process to indentify areas of improvement. It will also measure results of changes in the planning practice. The first version, including a ready to use survey, will be delivered in 2011.

The tool has been developed in close cooperation with Statoil and Petrobras, thus giving the opportunity to test the tool in different organizations, cultures and languages.

Can Integrated planning improve safety levels?
The IPL project has several master students working on IPL related topics. One of the projects focused on integrated planning and safety in connection with crane and lifting operations:

“Nine out of 10 fatal accidents on the Norwegian Continental Shelf since 1994 relate to lifting operations”

It was discovered that the main triggering causes for accidents/incidents in lifting operations were connected to lack of planning. With a total number of inbound and outbound lifts above 200,000 a year on a single installation, and indications that a single container would be moved 5 and 8 times during the stay onboard, this shows a significant area of improvement in planning. Thus, in order to reduce the risk for accidents/incidents there is an obvious need to improve the coordination of material being shipped offshore.
Program 4 Work Processes, Team Work and Collaborative Technologies

Discussing risk impact of maintenance operations.

Collaboration environment for safe maintenance planning
In 2010 data collected in maintenance planning studies from 2009 were analysed, to find answers to the question:
- How can future collaboration surfaces support safe planning of maintenance and modifications in distributed teams?

A new design for the IO Maintenance and Modification Planner (IO-MAP) test bed was developed. Based on this, a new study will be performed in 2011. The studies have identified central application areas and benefits of the IO-MAP technology:

- Risk visualization in connection with task and location planning, offering an extra highlight and reminder of risks on the map.
- Sharing expertise and situational understanding between team members with different background and different levels of operational experience. Assisting precise communication
- Intuitively visualising risk aspects of maintenance and minor modifications.
- At the individual level, IO-MAP makes it easier for the user to immediately recognize risks (e.g. relationships between tasks).

In addition to simplifying the design and improving the use of colours for better usability, the new design also supports a set of new functions including risk of falling objects, weather data, work load on disciplines and annotation of information about jobs and equipment such as procedure documents, photos and detailed visualisations (CAD, VR etc).

IO Mindset
The IO Mindset activity has focused on tools for assessment of organisational IO Mindset and the maturity of individuals, groups and organisations for IO implementation. Tools discussed include Technology Acceptance Model for IO, Collaboration Complexity Profile, IO Screening and the SOFIO Method (Structured Observation with Feedback of Collaboration in IO).
**Organization and leadership in condition monitoring processes**

A study of organization and leadership factors related to condition monitoring has identified possibilities for improvements, for example:

- Management should provide clear expectations about utilization of condition monitoring in maintenance planning.
- Process data should be better utilized for condition monitoring.
- There is a need for common understanding of procedures between disciplines related to installation, operation, maintenance and condition monitoring of equipment.
- Maintenance disciplines could be more proactive in searching information from companies’ condition monitoring centers. The integration between condition monitoring centers and maintenance governance functions can be improved, to make better use of condition monitoring information in maintenance processes.

**Guidance for reviewing IO teamwork training programs**

A report with guidance on how to conduct reviews of IO team training was published ([Supporting Review of IO Teamwork Training Programs. A Pilot Study](#), authored by Ann Britt Skjerve and Espen Nystad of IFE). This report presents an outline of a checklist for reviewing IO teamwork training programs, and accounts for its basis. The checklist will help determining to what extent a training program can be expected to achieve its goal[s].

**Resilience Engineering – a new approach to manage major accident risk**

Resilience Engineering is a new safety management approach, which has been developed and tested in several research activities, PhD works and master theses in Program 4. It consists of management principles and methods to facilitate a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions.

Resilience Engineering has been developed to cope with increasingly complex socio-technical systems that often pose a challenge to established safety approaches. It provides a way to address the issues of emergent accidents and the often disproportionate consequences that may be the result of even more complex technologies and integrated actors. Resilience Engineering methods are therefore going to be important tools in the management and assurance of safety in current and future IO systems.

Four abilities provide a basis both for engineering and managing resilience: monitoring ongoing processes; anticipate future developments; respond to regular and irregular disruptions; and learn from failures and success. IO concepts such as improved access to real-time information and closer interaction among actors can improve these resilient abilities in offshore activities.

**Some main results among the resilience engineering activities in the IO Safe project:**

- A tool to evaluate resilient abilities in integrated planning
- Tools and conceptual models of how to include assessment of resilience in operational risk management
- Advices on how to use IO-concepts to enable resilient abilities in proactive emergency management
- Case studies by using a function-based method for safety assessment to describe and analyze the role of performance variability in complex socio-technical systems
- Studies on how onshore support improves resilience in offshore activities
5. General Projects

**Improved decisions ...**
**improved performance ... How much?**

IO is the integration of people, work processes and technology to make smarter decisions and better execution. Therefore, we have developed a pragmatic decision analytic framework to assess monetary value of IO. The framework builds on contemporary literature for assessing technology in a broader context of organizational structures and work processes. The novelty lies in its efficiency and methodological guidelines on how to relate qualitative assessment of changes in competencies to quantitative decision analysis by assessing:

- Value of information;
- Value of control;
- Value of flexibility;
- Efficiency.

Year 2010 was a productive year for the project that allowed:

- Validating the framework in a greenfield project with Total E&P;
- Refining parameters for qualitative study of intangibles;
- Refining and finalizing a prototype tool;
- Verifying the tool in a case study with Sintef Marintek.

![Figure: Analytical cubes to study intangible and tangible benefits of IO.](image)

The two case studies performed in 2010 and one in 2009 let us concluding with the confidence that:

- The framework is flexible, efficient and effective in delivering useful insights and calculating monetary value.

**IO Survey Across Industrial Sectors**

The IO Survey Across Industrial Sectors is a newly started project in 2010 and runs for 2011. The intention is to investigate IO principles in other industries and to highlight the synergies between these industries and the oil and gas industry regarding IO applications.

The selected industries are: medical, military and aviation. Topics to be addressed:

- Advanced deployment of technology, systems and organizational structures
- People, competence, culture and work processes
- Synergies across branches
- Lessons learned – implication for the O&G
- Think tank seminars between industry partners and IO Center

The project has established an IO Center core team with participants from the four R&D programs. Further we have established an expert team with people from each of the three industries.

We are developing a systematic questionnaire for making comparative studies between the O&G industry and the three other industries. The basis for the common reference will be a stack model in use in the O&G industry and highlighting team work and capabilities and enabling technologies.

We will also test out the definition of IO in the different industries: “IO is the integration of people, work processes and technology to make smarter decisions and achieve better execution. It is enabled by the use of ubiquitous real time data, collaborative techniques and multiple expertises across disciplines, organizations and geographical locations”.

![Image](image)
The Annual International IO Conference organized by the IO Center

IO 10 Science and Practice Conference
The 6th international conference on integrated operations in the petroleum industry – IO10 Science and Practice – was arranged by the IO Center 28-29 September. The main topic was "Intelligent petroleum fields and integrated operations – the next generation".

The annual IO Conferences provides an arena for an international meeting place on IO where industry and research share knowledge and experience and build network. The conference reviews trends and opportunities and is a place where science and practice meet. IO10 had 300 participants, 35 speakers and a very good international attendance.

The conference is a unique international network place. The Advisory Board has representatives from SaudiAramco, Petrobras, Petronas and Qatar Petroleum as well as the international oil companies that support the IO Center as partners.

IO 11, The 7th International IO Conference, Trondheim 13-14 September 2011
For more information, see: www.ioconf.no

Education

Master students
Education of master students with background in IO related subjects is a very important result for our industrial partners. The candidates will enter important positions in the oil and gas industry and contribute to implementation of IO from the first working day. Many of the students projects are conducted in cooperation with the industry partners in the IO Center. 30 master students being affiliated with the IO Center have graduated in 2010. The majority of the students have been recruited by service suppliers and oil companies.
The organization chart and governance model is shown in the figure below. The Board and the Technical Committee meet twice a year. Board and TC members can access reports and other project information through a web site. The sub project teams are populated by researchers from NTNU, SINTEF and IFE, and guest researchers from four international cooperating universities. Research is performed at five locations in Norway; Trondheim, Oslo, Halden, Bergen and Stavanger, in addition to the pilot project sites onshore and offshore and at the international universities. Communication internally and across activities is organized through physical and virtual meetings, use of a common project database and email communication. The PhD students arrange regular colloquia. The PhD students work 25% of their time as researchers in the sub projects, in order to get exposed to industrial processes and applications of new technology. Collaboration with the industry is organized through 15 pilot projects and about 10 workshops per year for transfer of knowledge.
Gender distribution

<table>
<thead>
<tr>
<th>Category</th>
<th>% Female</th>
<th>Target</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD students</td>
<td>30</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Research Scientists</td>
<td>30</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Project managers</td>
<td>30</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Board</td>
<td>30</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

In connection with recruitment of PhD students, the announcements have stimulated women to apply for positions. Female participation has also been one of the criteria for hiring sub project managers and program managers. However, in both cases we have experienced problems with finding sufficient number of female candidates.

International co-operation

The board

- Jon Klappe, NTNU, Chair
- Kjell Ola Jørgensen, GDF Suez
- Brage Sandstad, ConocoPhillips
- Erik Østby, Det Norske Veritas
- Nora Bergseth, Eni Norge AS
- Christina M. Johansen, FMC Kongsberg
- Anders Holme, Aker Solutions
- Jon Stærkebye, IBM
- Kjell Iola Jørgensen, GdF Suez
- Cristina Pinho, Petrobras
- Terje Ulltang, Statoil
- Tom Gunnar Omberg, Shell
- Tore Øst, Total E&P Norge
- Fridtjof Øvrel, Institute for Energy Technology
- Kjell Arne Jacobsen, SINTEF Petroleum Research
- Ingvald Strømmen, NTNU
- Tor Peter Johnsen, Research Council of Norway (observer)
- Jon Lippe, NTNU, Secretary of the Board
People in the IO Center

Center Management

Jon Kleppe  
Center director  
NTNU

Jon Lippe  
Operational manager  
NTNU

Solveig Johnsen  
Project Coordinator  
NTNU

Arlid N. Nystad  
Advisor Petromanagement AS

Program Managers

Tor Stein Ølberg  
Program 1: Drilling and Well Construction  
SINTEF

Bjarne Foss  
Program 2: Reservoir Management and Production Optimization  
MARINTEK

Anders Valland  
Program 3: Work Processes, Team Work and Collaborative Technologies  
IFE

Jon Kvalem  
Operational manager  
NTNU

Center director  
NTNU

Asgeir Tomasgard  
IO Valuation Model  
MARINTEK

Sub Project Managers

Roald Kluge  
1.1 Integrated Drill. Simulator  
SINTEF

Svein Hovland  
1.1 Integrated Drill. Simulator  
SINTEF

Roar Nybe  
1.2 Diagnostic Tool  
SINTEF from Sept 2009

Torbjørn Korsvold  
1.3 Work Processes and Experience Transfer  
IFE

Espen Kristoffersen  
1.4 Utilization of Increased bandwidth from borehole  
SINTEF

Stein Krogstad  
2.1 Reservoir management  
SINTEF

Davide Roverso  
3.1 Conditioning based Monitoring and Maintenance support, IFE

Torgeir Brurok  
3.2 Conditioning Monitoring  
MARINTEK

Aud Marit Wahl  
3.3 Integrated planning  
MARINTEK

Grete Rindahl  
4.1 Future Collaboration Environments  
IFE

Sjur Larsen  
4.2 Work Processes and Decision Making Studio Apertura

Eirik Albrechtsen  
4.3 Integrated Operations and Safety  
SINTEF

Asgeir Tomasgard  
IO Valuation Model  
MARINTEK

Torgeir Brurok  
3.2 Conditioning Monitoring  
MARINTEK

Aud Marit Wahl  
3.3 Integrated planning  
MARINTEK

Grete Rindahl  
4.1 Future Collaboration Environments  
IFE

Sjur Larsen  
4.2 Work Processes and Decision Making Studio Apertura

Eirik Albrechtsen  
4.3 Integrated Operations and Safety  
SINTEF

Asgeir Tomasgard  
IO Valuation Model  
MARINTEK

Ph.d students

Matthias Bellout  
NTNU

Agus I Hasan  
NTNU

Vidar Gunnerud  
NTNU

Eka Suwartadi  
NTNU

Øystein Veland  
NTNU

Stig Oie Johnsen  
NTNU

Silvia Dewi Rahmawati  
NTNU

Richard Rwechungura  
NTNU

Kristin Halvorsen  
NTNU

Camilla Tveiten  
NTNU

Pratichi Vaidya  
NTNU

Gisle Andresen  
NTNU

Alexander Juell  
NTNU

Michael Wartmann  
Carnegie Mellon University

Vahid Aziz  
UIS

Brage Knudsen  
NTNU

Geir Guttormsen  
NTNU, Associated

Torgeir Haavik  
NTNU, Associated

Pratichi Vaidya  
NTNU

Gisle Andresen  
NTNU

Alexander Juell  
NTNU

Michael Wartmann  
Carnegie Mellon University

Vahid Aziz  
UIS

Brage Knudsen  
NTNU

Geir Guttormsen  
NTNU, Associated

Torgeir Haavik  
NTNU, Associated
Research Scientists

Johnny Freyen
SINTEF

Knut Bjerkevoll
SINTEF

Espen Nystad
IFE

Petter Almklev
NTNU

Ingrid Schjølberg
SINTEF

Mario Hoffmann
IFE

Asgeir Dreivoldsø
IFE

Anders Lauvsnes
SINTEF

Ann Britt Skjerve
IFE

Odd Falmyr
IFE

Hans Olav Randem
IFE

Bjørn Emil Madsen
SINTEF

Margit Hermundsgard
SINTEF

Lisbeth Hansson
SINTEF

Terje Bodal
IFE

Tor Arne Reinen
SINTEF

Sizarta Sarshar
IFE

Curtis Whitson
NTNU

Per Morten Schieflø
NTNU

Jern Vatn
NTNU

Harald P. J. Thunem
IFE

Hans Martin Helset
IFE

Svein Nilsen
IFE

Tone Berg
SINTEF

Are Haugan
IFE

Thor Ole Guhrsud
SINTEF

Svein Hovland
MARINTEK

Karsten Opel
IFE

Lone Ramstad
MARINTEK

Alexey Stovas
NTNU

Erik Hennie
MARINTEK

Martin Landre
NTNU

Johannes Tjennás
SINTEF

George W. Halsey
SINTEF

Johnny Petersen
SINTEF

Irene Wærø
SINTEF

Giulio Gola
IFE

Mellon Dillen
SINTEF

Michael Jordan
SINTEF

Harald Radseth
SINTEF

Federico Zenith
SINTEF

Sture Holmstrom
SINTEF

Bernt A. Bremdal
SINTEF

Michael Golan
NTNU

Jaising Hitesh
SINTEF

Postdoctoral researchers

Prof. Erik Hollinagel
Ecole de Mines/Armines

Prof. Erik Hollinagel
Carnegie Mellon University

Bernst Aadnøy
University of Stavanger

Delfina Gevius
Gevius & Associates, LLC

Darjus Strassinskas
NTNU

David Echeverria Casarri
Stanford University

Mohsen Dadashpoo
NTNU

Aminul Islam
NTNU • Associated
The IO Center was established in 2006, by leading international oil companies, system suppliers, academic institutions and the Research Council of Norway, with the objective to undertake research, innovation and education on integrated operations.

Contact persons
Professor Jon Kleppe, Ph.D, Center Manager
Phone: + 47 918 97 300, + 47 73 59 49 33
Email: jon.kleppe@ntnu.no

Jon Lippe, Operational Manager
Phone: + 47 918 97 033, + 47 73 59 02 33
Email: jon.lippe@ntnu.no

Arild N. Nystad, Ph.D, Innovation & industrial relations
Phone: + 47 913 22 497, + 47 51 56 71 11
Email: arild.nystad@petromanagement.com

Solveig Johnsen, Project Coordinator
Phone: + 47 481 47 327, + 47 73 59 49 57
Email: solveig.johnsen@ntnu.no

IO Center
S. P. Andersens v. 15 A, 7491 Trondheim, Norway
Telephone: +47 73 59 49 25
Telefax: +47 73 94 44 72

Visit our web site www.iocenter.no for more information and downloading of published reports and papers

Research partners

Industrial partners

Collaborating international academic partners